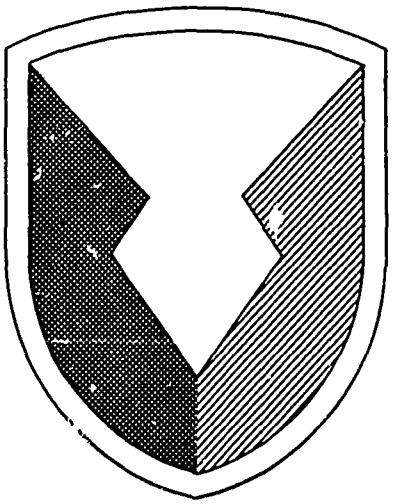
US ARMY TEST & EVALUATION COMMAND



FINAL REPORT OF

MILITARY POTENTIAL TEST

OF THE

ELECTRONIC BLADE TRACKER

DA PROJECT NO. 1D141812D18501

USATECOM PROJECT NO. 4-4-5003-01

US ARMY
AVIATION TEST BOARD
FORT RUCKER, ALABAMA

(11) 25 Jan 65

(12) 23 P.

UNITED STATES ARMY AVIATION TEST BOARD
Fort Rucker, Alabama 36362

(9) FINAL REPORT, 18 Aug - 24 Sep 64.

(6) MILITARY POTENTIAL TEST

OF THE

ELECTRONIC BLADE TRACKER,

(16) DA [redacted] NO. 1D141812D18501,

USATECOM [redacted] NO. 4-4-5003-01

A. J. RANKIN
Colonel, Armor
President

036500

ABSTRACT

The US Army Aviation Test Board conducted a military potential test of the Model 1165B Electronic Blade Tracker at Fort Rucker, Alabama, and in the vicinity of Fort Jackson, South Carolina, during the period 18 August - 30 September 1964. Two previously-reported deficiencies were not corrected. Three additional deficiencies and four shortcomings were noted during this test. It was concluded that correcting the deficiencies will make the blade tracker suitable for Army use and correction of the shortcomings will enhance the suitability. It was recommended that the deficiencies be corrected and a check test be performed, and that the shortcomings be corrected as practicable.

FINAL REPORT OF

MILITARY POTENTIAL TEST OF THE

ELECTRONIC BLADE TRACKER

USATECOM PROJECT NO. 4-4-5003-01

Table of Contents

SECTION 1 - GENERAL

1.1. REFERENCES.

a. Plan of Test, "Helicopter Rotor Tracker, Federal Stock Number 4920-M54-0038," US Army Transportation Materiel Command Aviation Test Office, undated.

b. Report, ATO-TR-62-4, "Evaluation of the Electronic Blade Tracker," US Army Transportation Materiel Command Aviation Test Office, May 1962.

c. Letter, SMOSM-EH/H. T. 1.17, US Army Aviation and Surface Materiel Command, 18 December 1963, subject: "Request for Test, Electronic Blade Tracker," with two indorsements.

d. Message TT4179, US Army Test and Evaluation Command, 16 March 1964, subject: "Electronic Blade Tracker."

e. Plan of Test, USATECOM Project No. 4-4-5003-01, "Military Potential Testing of an Electronic Blade Tracker," US Army Aviation Test Board, 13 April 1964.

f. Manufacturer's Operating Manual, dated 24 June 1964.

g. Manufacturer's Maintenance Manual, dated 25 June 1964.

1.2. AUTHORITY.

1.2.1. Directive.

Letter, SMOSM-EH/H. T. 1.17, US Army Aviation and Surface Materiel Command, 18 December 1963, subject: "Request for Test, Electronic Blade Tracker," with 1st Indorsement, AMSMO-RDT (18 Dec 63), US Army Mobility Command, 20 December 1963, and 2nd Indorsement, AMSTE-BG (18 Dec 63), US Army Test and Evaluation Command, 16 January 1964.

1.2.2. Purpose.

To determine the Military Potential of the Model 1165B Blade Tracker.

1.3. OBJECTIVES.

To determine:

a. Physical characteristics.

b. Complexity and adequacy of calibration procedures.

c. Functional and operational capabilities.

d. Adequacy of the maintenance package.

e. Personnel training requirements.

f. Maintenance requirements.

g. Correction in the Model 1165B of the deficiencies found during testing of the Model 1165A Electronic Blade Tracker.

1.4. RESPONSIBILITIES.

1.4.1. The US Army Aviation Test Board (USAAVNTBD) was responsible for the test plan preparation, test execution, and test reporting.

1.4.2. The US Army Aviation Materiel Command was responsible for furnishing the test item and technical support as required.

1.5. DESCRIPTION OF MATERIEL.

1.5.1. The Electronic Blade Tracker Model 1165B is a device for detecting differences in the rotational planes of helicopter rotor blades. The tracker consists of a scope assembly equipped with a 5-inch cathode-ray tube which displays the track condition of the blades, a stand assembly supporting a pick-up head assembly, and the necessary service and signal cables. The tracker requires either a 12- or 28-volt d.c. power source.

1.5.2. The tracker uses the capacitance principle to detect and display track condition. A capacitance signal, generated as the blade passes over the pick-up head, is converted to linear voltage and is displayed as a vertical trace line on the scope. The distance of the

trace line above a base line indicates the distance that the blades are out of track. A counter and selector system enables the operator to select from two to ten blades depending on the type helicopter being tracked and insures that each blade trace remains in the same numbered position on the scope. This makes it possible to display all blade traces simultaneously which permits comparison of vertical trace heights. Blade identification is accomplished by observing the blades as they pass over the pick-up and noting the numbered position in which the vertical trace appears during the coast-down of the rotor.

1.6. BACKGROUND.

1.6.1. For maximum efficiency, helicopter rotor blades must rotate in the same relative plane. Consequently, a requirement exists for a device that can detect an out-of-track condition. The device currently used is a tracking flag which is simple in design and accurate when used on small helicopters. However, with the advent of larger and more sophisticated helicopters, its use is not practical due to rotor downwash and personnel safety requirements.

1.6.2. The Model 1165A Electronic Blade Tracker was tested by the US Army Aviation Test Activity, Edwards Air Force Base, California, in May 1962. Twelve deficiencies were found during this test and the equipment was not adopted for Army use. The Model 1165B tracker incorporated modifications which were intended to correct these deficiencies.

1.6.3. The Model 1165B blade tracker was received for test at the USAAVNTBD on 1 August 1964.

1.7. FINDINGS.

1.7.1. The physical characteristics of the blade tracker were satisfactory. The equipment could be packed into two carrying cases measuring 31 x 10.5 x 19 inches and 50 x 23 x 19 inches. Total weight was 124 pounds.

1.7.2. While calibration could be accomplished, difficult procedures made the method unsuitable.

1.7.3. Functional and operational capabilities of the blade tracker were inadequate.

1.7.4. The manufacturer's operating and maintenance manuals were inadequate in content and did not conform to the Army format. No special tools were required.

1.7.5. Eight hours of formal training and twelve hours of on-the-job training were required to train a helicopter mechanic to operate the test item. An Aviation Electronic Equipment Mechanic, MOS 284.1, would require 40 hours of formal training to perform electronic maintenance.

1.7.6. One welding repair operation was the only maintenance required during the test. No parts were replaced. Avionic maintenance personnel would be required to perform all electronic maintenance.

1.7.7. Of the 12 deficiencies previously reported (reference b), six were corrected and two were not corrected. The status of four could not be determined due to lack of a wiring diagram for the Model 1165A; however, problems resulting from these deficiencies were not encountered. Three additional deficiencies and four shortcomings were noted during this test.

1.8. CONCLUSIONS.

1.8.1. Correcting the deficiencies listed in appendix I will make the Model 1165B Electronic Blade Tracker suitable for Army use.

1.8.2. Correction of the shortcomings listed in appendix I will enhance the suitability of the Model 1165B Electronic Blade Tracker.

1.9. RECOMMENDATIONS.

It is recommended that:

1.9.1. The deficiencies listed in appendix I be corrected and a check test of the Model 1165B Electronic Blade Tracker be performed.

1.9.2. The shortcomings listed in appendix I be corrected as practicable.

SECTION 2 - DETAILS AND RESULTS OF SUBTESTS

2.0. INTRODUCTION.

2.0.1. The US Army Aviation Test Board (USAAVNTBD) conducted a military potential test of the Model 1165B Electronic Blade Tracker at Fort Rucker, Alabama, and in the vicinity of Fort Jackson, South Carolina, during the period 18 August 1964 through 30 September 1964. A total of 27 blade-tracking operations were performed. Emphasis was placed on determining the status of previously-reported deficiencies.

2.0.2. Previous plans and reports of test have been researched and pertinent information considered.

2.1. PHYSICAL CHARACTERISTICS.

2.1.1. Objective.

To determine the physical characteristics of the electronic blade tracker.

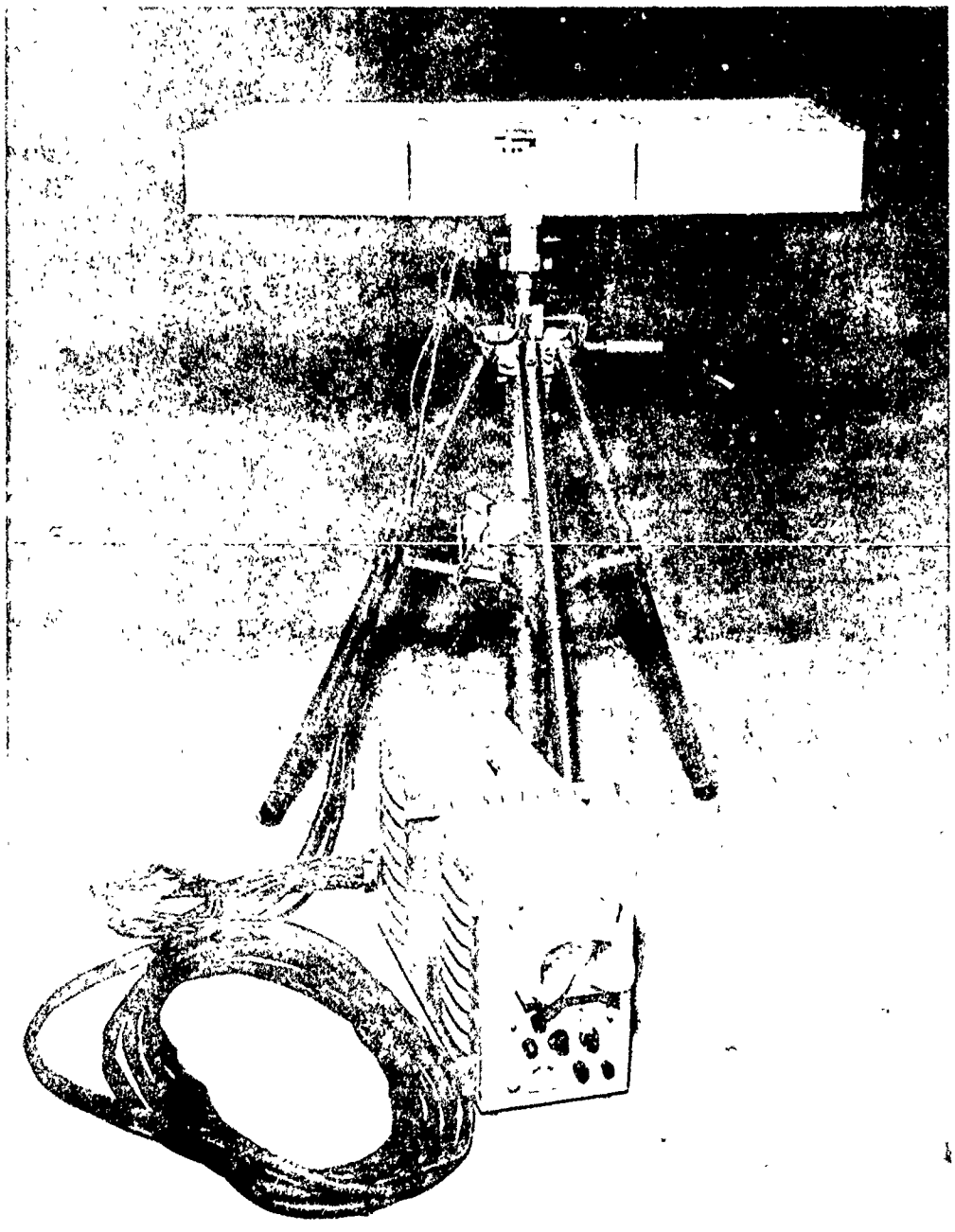
2.1.2. Method.

Components of the test item were weighed, measured, and visually inspected.

2.1.3. Results.

The physical characteristics of the blade tracker were as follows:

	Length (in.)	Width (in.)	Height (in.)	Weight (lb.)	Wire Lengths
Scope	28	9	13	45	Service cord 5 feet Signal cord 30 feet
Scope Carrying Case	31	10.5	19	14	



Model 1165B Electronic Blade Tracker

	Length (in.)	Width (in.)	Height (in.)	Weight (lb.)	Wire Lengths
Stand Assembly					
a. Pick-up Head	36	36	8	15	
b. Tripod			47 to 107*	25	Ground wire 50 feet
Stand Carrying Case	50	23	19	25	
TOTAL WEIGHT				124	

*Adjustable in six-inch increments.

2.1.4. Analysis.

Not applicable.

2.2. CALIBRATION PROCEDURES.

2.2.1. Objective.

To determine the complexity and adequacy of the calibration procedure.

2.2.2. Method.

The test item was calibrated using procedures recommended in the Operator's Manual.

2.2.3. Results.

2.2.3.1. The calibration procedures were complex due to the sensitivity of the equipment. A routine procedure for calibration could not be established because adjustments that would bring the equipment into calibration at one time would not apply to another. Calibration in each instance was accomplished by trial and error. The location of the

capacitance adjustment knob in the pick-up head assembly required the operator to walk between the pick-up head and scope assembly as many as three to five times during the calibration sequence.

2.2.3.2. On numerous occasions, the calibration of the equipment was changed by accidentally bumping the adjustment knobs during the tracking operation. The capacitance adjustment was extremely sensitive and could be changed by merely touching the adjustment knob.

2.2.4. Analysis.

While calibration could be accomplished, difficult procedures made the method unsuitable.

2.3. FUNCTIONAL AND OPERATIONAL CAPABILITIES.

2.3.1. Objective.

To determine the functional and operational capabilities of the electronic blade tracker.

2.3.2. Method.

2.3.2.1. Three main rotor tracking operations were performed on each of the following helicopters: OH-13, UH-1, UH-19, CH-21, CH-37, and CH-47. (The UH-19 was used in lieu of the CH-34 because a CH-34 was not available during the test period.)

2.3.2.2. Three antitorque rotor tracking operations each were performed on each of the following helicopters: OH-13, UH-1, and CH-37.

2.3.2.3. The tracking operation was performed from known out-of-track conditions ranging from 1/2 to 2 inches. After each correction, the out-of-track condition was redetermined using the electronic blade tracker.

2.3.2.4. Verification of each track was made using Rotor Blade Tracker WM-1 (Federal Stock No. 4920-590-6771), and/or a rotor blade tracking flag.

2.3.2.5. Three tracking operations were performed with relative humidity above 85 percent and three were performed with relative humidity below 35 percent.

2.3.2.6. The blade tracker was transported 25 miles over improved and unimproved roads on an Army 3/4-ton truck. A tracking operation was performed when the trip was completed.

2.3.3. Results.

2.3.3.1. The blade tracker operated satisfactorily on the OH-13, UH-1, UH-19, CH-21, CH-37, and CH-47.

2.3.3.2. In order to track the aft rotor on the CH-21 and the CH-47 and the main rotor of the CH-37, a B-1 maintenance platform (Federal Stock No. 1730-390-5618) was used to provide sufficient height for the pick-up head. The maintenance platform used is a component of ground handling sets A, B, and C.

2.3.3.3. The tripod stand had to be weighted or tied down to reduce the possibility of being blown over by the rotor downwash of the larger helicopters (CH-37 and CH-47).

2.3.3.4. The pick-up head assembly, when adjusted for flat tracking, was low when collective pitch was applied to the blades. This was due to the increase in distance (blade coning) between the blades and pick-up head assembly. As a result of this increased distance, the signal displayed on the scope was weak and unreliable.

2.3.3.5. No problems were encountered during antitorque rotor tracking operations.

2.3.3.6. Blade-to-scope-trace identification was difficult. This was accomplished by observing the blade as it approached the pick-up plate after engine shut-down and by identifying each specific colc blade with a trace on the scope.

2.3.3.7. The results of each step of the tracking operation as verified using a tracking flag and/or a WM-1 Rotor Blade Tracker substantiated the results measured by the Model 1165B tracker.

2.3.3.8. Neither high nor low humidity had any noticeable effect on the operation of the blade tracker.

2.3.3.9. The tracker continued to operate normally after being transported over improved and unimproved roads.

2.3.4. Analysis.

Not applicable.

2.4. MAINTENANCE PACKAGE.

2.4.1. Objective.

To determine the adequacy of the maintenance package.

2.4.2. Method.

The blade tracker was operated and maintained using the manufacturer's operating and maintenance publication.

2.4.3. Results.

The manufacturer's operating and maintenance manuals were inadequate in content and did not conform to the Army format. No special tools were required.

2.4.4. Analysis.

The operating and maintenance manuals were inadequate in content and did not conform to the Army format. Manuals did not include sufficient illustrations (e.g., showing equipment set up for tracking each type of Army helicopter). Calibration instructions were inadequate, and manuals did not include explanation of such items as erroneous trace on the oscilloscope.

2.5. PERSONNEL TRAINING.

2.5.1. Objective.

To determine personnel training requirements.

2.5.2. Method.

2.5.2.1. Three military helicopter mechanics with the following MOS's were trained to use the test item:

a. 675.20 - Single-Rotor Turbine Utility Helicopter Mechanic

b. 675.30 - Single-Rotor Utility and Cargo Helicopter Mechanic

c. 676.20 - Single-Engine Tandem-Rotor Helicopter Mechanic

2.5.2.2. Avionics maintenance personnel inspected the test item to determine training requirements to maintain the electronic circuitry.

2.5.3. Results.

2.5.3.1. Eight hours of formal training and twelve hours of on-the-job training in the operation and use of the tracker with special emphasis on reading the oscilloscope were required to operate the equipment.

2.5.3.2. Inspection of the equipment revealed that an Aviation Electronic Equipment Mechanic, MOS 284.1, would require 40 hours of formal training to perform maintenance of the electronic circuitry.

2.5.4. Analysis.

Since no electronics maintenance was required, training requirements could not be confirmed (see paragraph 2.6.3 below).

2.6. MAINTENANCE REQUIREMENTS.

2.6.1. Objective.

To determine maintenance requirements.

2.6.2. Method.

All maintenance operations and time required were recorded.

2.6.3. Results.

The equipment did not require electronic maintenance. A separation occurred where the tripod legs mount on the telescoping mast. A welding repair required 45 minutes.

2.6.4. Analysis.

An inspection of this equipment revealed that electronic maintenance must be performed by avionic maintenance personnel (see paragraph 2.5.3.2 above).

2.7. DEFICIENCIES FOUND DURING MODEL 1165A TESTING.

2.7.1. Objective.

To determine whether the deficiencies found during testing of the Model 1165A tracker were corrected in the Model 1165B.

2.7.2. Method.

Operation of the Model 1165B was observed to determine whether the deficiencies of the Model 1165A were corrected.

2.7.3. Results.

Observation of the Model 1165B operation during the test revealed that six deficiencies which existed in the Model 1165A were corrected. Two deficiencies were not corrected. The status of four of the deficiencies could not be determined due to lack of a wiring diagram for the Model 1165A; however, problems resulting from these deficiencies did not occur during this test.

2.7.4. Analysis.

Details are contained in appendix I.

SECTION 3

APPENDICES

APPENDIX I - DEFICIENCIES AND SHORTCOMINGS

A. STATUS OF PREVIOUSLY-REPORTED DEFICIENCIES. The status of the deficiencies found during testing of the Model 1165A blade tracker (reference b) is contained in this appendix. Where positive determination could not be made due to nonavailability of a wiring diagram of the Model 1165A tracker, the operation was monitored to determine whether the problems resulting from these deficiencies were encountered in the Model 1165B.

Deficiency	Status	Remarks
1. Stabilization of detector head assemblies operating temperature needs improvement.	Undetermined	The problems that resulted from this deficiency were not encountered during the Model 1165B test.
2. The operating voltage range needs to be increased.	Corrected	None.
3. The automatic voltage control should be relocated to provide adequate heat sinking.	Undetermined	The problems that resulted from this deficiency were not encountered during the Model 1165B test.
4. Low frequency input to the oscilloscope should be removed by the use of a filter(s).	Not corrected	Erroneous traces were noted on the oscilloscope screen. Cause was undetermined.
5. Amplitude "large" and "small" knobs should be divided.	Corrected.	None.

Deficiency	Status	Remarks
6. The tail rotor plate should be removed from the test stand.	Corrected	None.
7. Formica guards around the main-rotor plate require extension to prevent capacitance end effects.	Corrected	Formica guards have been extended and no difficulties were experienced.
8. The transformer on the cathode ray tube's power supply requires improvement.	Undetermined	The problems reported as a result of deficiency during the 1165A test were not experienced.
9. Equipment tracking accuracy must be improved.	Corrected	None.
10. Manufacturer must establish better methods of quality control.	Undetermined	The problems experienced as a result of poor quality control during the Model 1165A test were not experienced during testing of the Model 1165B.
11. An average tracking height must be established for all helicopter blades.	Corrected	None.
12. The maintenance manual must be rewritten and illustrated to better serve its purpose.	Not corrected	Contents of operating and maintenance manuals were inadequate.

B. DEFICIENCIES AND SHORTCOMINGS DISCOVERED DURING THIS TEST.

1. DEFICIENCIES.

Deficiencies	Suggested Corrective Action	Remarks
a. Tripod height was insufficient for tracking the aft rotor of the CH-21 and CH-47 and the main rotor of the CH-37.	Add 30 inches to the basic stand height and 30 inches to the telescopic extension height.	None.
b. Pick-up assembly stand blows over when placed in rotor downwash of large helicopters.	Widen tripod base and modify the leg mounts to increase stability.	None.
c. Range of pick-up head was insufficient when blade pitch was applied on CH-37 and CH-47 helicopters.	Increase range of pick-up head to allow for blade coning.	None.

2. SHORTCOMINGS.

Shortcomings	Suggested Corrective Action	Remarks
a. Calibration procedures were complex.	Simplify the calibration procedures. (See paragraph 2.2.3.1.)	None.
b. Blade identification was difficult.	Provide a means to make one blade readily stand out on the scope.	This modification should not require hardware mounted in the aircraft.

Shortcomings	Suggested Corrective Action	Remarks
c. Calibration knobs could be accidentally moved during the tracking operation.	Incorporate locks on all of the knobs.	None.
d. Location of capacitance adjustment knob in pick-up head required operator to walk back and forth between pick-up head and scope during calibration sequence.	Relocate the adjustment knob to the scope assembly.	None.

APPENDIX II - COORDINATION

The following agencies participated in the review of the test report:

US Army Aviation School

US Army Combat Developments Command Aviation Agency

APPENDIX III - DISTRIBUTION LIST

USATECOM PROJECT NO. 4-4-5003-01

Agency	Final Reports
Commanding General US Army Test and Evaluation Command ATTN: AMSTE-BG Aberdeen Proving Ground, Maryland 21005	2
Commanding General US Army Aviation Materiel Command ATTN: SMOSM-U P. O. Box 209, Main Office St. Louis, Missouri 63166	25

AD_____ Accession No._____

US Army Aviation Test Board, Ft. Rucker, Ala. Report of USATECOM Project No. 4-4-5003-01, Military Potential Test of the Electronic Blade Tracker, 22 January 1965. DA Project No. 1D141812D18501. 28 pp., 1 illus. Unclassified report. The USAAVNTBD conducted a military potential test of the Model 1165B Electronic Blade Tracker at Ft. Rucker, Ala., and in the vicinity of Ft. Jackson, S. C., during the period 18 Aug - 30 Sep 1964. Two previously-reported deficiencies were not corrected. Three additional deficiencies and four shortcomings were noted during this test. It was concluded that correcting the deficiencies will make the blade tracker suitable for Army use and correction of the shortcomings will enhance the suitability. It was recommended that the deficiencies be corrected and a check test be performed, and that the shortcomings be corrected as practicable.

AD_____ Accession No._____

US Army Aviation Test Board, Ft. Rucker, Ala. Report of USATECOM Project No. 4-4-5003-01, Military Potential Test of the Electronic Blade Tracker, 22 January 1965. DA Project No. 1D141812D18501, 28 pp., 1 illus. Unclassified report. The USAAVNTBD conducted a military potential test of the Model 1165B Electronic Blade Tracker at Ft. Rucker, Ala., and in the vicinity of Ft. Jackson, S. C., during the period 18 Aug - 30 Sep 1964. Two previously-reported deficiencies were not corrected. Three additional deficiencies and four shortcomings were noted during this test. It was concluded that correcting the deficiencies will make the blade tracker suitable for Army use and correction of the shortcomings will enhance the suitability. It was recommended that the deficiencies be corrected and a check test be performed, and that the shortcomings be corrected as practicable.